RECOMMENDED SAFETY STANDARDS FOR SHAFT SINKING

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UNITED STATES DEPARTMENT OF THE INTERIOR
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INTRODUCTION

Unfortunate occurrences resulting in injuries, loss of life, and destruction of property by explosion, fire, and other mishaps during shaft sinking in the past few years have focused the attention of the Bureau of Mines on the need for safety standards for such operations.

Several States have some rules and regulations applicable to local conditions, and several Bureau publications (including some now out of print) cover the hazards that may be encountered in shaft sinking. Certain requirements of the Federal Mine Safety Code and Federal Coal Mine Safety Act may be applied, but there are no definite, uniform standards that will guide those desiring to sink a shaft safely and bring about uniform safety inspections.

The recommended standards included in this publication have been carefully compiled by Bureau personnel in all areas where shaft sinking is practiced. Existing applicable State rules were considered and included. Representatives of the mineral industries, coal and noncoal, were given an opportunity to participate in preparing these suggested standards, and the Bureau hopes that their use will lead to greater safety and efficiency and prevent loss of life, injury, and property damage during shaft sinking.

RECOMMENDED SAFETY STANDARDS FOR SHAFT SINKING

(1) Fire Prevention

1.01. Buildings within 50 feet of a shaft opening should be reasonably fireproof or fire resistant.

1.02. Wooden boards, rails, beams, posts, ties, or other combustible material in excess of 1 day's supply should not be stored within 50 feet of a shaft opening. Shaft timbers should be fire resistant.

1.03. Oil, gasoline, and other petroleum products should be kept in closed, safe containers. Not more than 1 day's supply of such products should be stored within 100 feet of a shaft opening. Measures should be taken to insure drainage of flammable liquids away from the shaft in case of spillage. These products should not be stored in the same building with other combustible materials, unless separated therefrom by fire-resistant partitions.

1.04. Oily rags, waste, waste paper, and other similar combustibles should be kept in closed metal containers until removed for disposal.

1.05. Smoking should be restricted to places where the practice will not create fire or explosion hazards.

1.06. Oxygen and acetylene cylinders, other than those in use during the current shift, should be stored not less than 100 feet from shaft openings; all should be properly secured.

1.07. Pyritic slates, bony coal, culm, or other material capable of spontaneous combustion should not be used for fill or surfacing material in the vicinity of a shaft opening.

(2) Fire Protection

2.01. An adequate amount of suitable fire-fighting equipment, such as fire hydrants, hose and nozzles, chemical trucks, fire extinguishers, barrels of water with pails, sand, and rock dust, should be readily accessible and plainly marked. In selecting equipment, care should be taken to provide for all classes of fire; namely:

Class A - Solid combustible materials.

Class B - Flammable liquids.

Class C - "Live" electrical equipment.

(For details, see Appendix and Bureau of Mines Information Circular 7662.)

2.02. Fire-hydrant couplings should be standard and interchangeable with those of the local fire departments, or suitable adapters should be provided.

2.03. Fire-fighting equipment should be thoroughly examined monthly to detect any damage or deterioration and tested at intervals recommended by the respective manufacturers.

2.04. Personnel who may be required to use fire-fighting equipment should be instructed in the proper use of such equipment.

2.05. Fire-fighting equipment should be readily available in the immediate location when welding, torch-cutting, or burning waste paper, wood, and general refuse. Also, fire-fighting equipment should be installed on electric or diesel-engine-driven equipment operated in shafts, or should be readily available in the location where such equipment is used. A vehicle transporting explosives should be provided with a fire extinguisher of suitable type. In each instance, the equipment provided should be at least one unit as per table in the appendix.

2.06. A distinctive fire alarm should be provided.

2.07. Heating equipment should be installed so that fire cannot be caused if overheating occurs.

(3) Housekeeping and Sanitation

3.01. Good housekeeping should be practiced in and around the shaft, buildings, and work, parking, and storage areas. Such practices include cleanliness, orderly storage of materials, and removal of possible sources of injury, such as stumbling hazards, protruding nails, broken glass, and materials that might fall or roll.

3.02. Paths and walkways adjacent to structures, which are required to be used by workmen in performing their work, should be kept free of obstructions and should be suitably illuminated when required to be used at night.

3.03. Where wash houses, change houses, or rooms for such purposes are provided, the houses or rooms should be properly heated, ventilated, illuminated, and kept clean. An ample supply of warm water should be available in wash houses.

(4) Electricity

4.01. Overhead high-potential (over 650 volts) powerlines should be at least 15 feet above the ground, 20 feet above driveways and haulageways, and 28 feet above railroad tracks; they should be installed on insulators and supported and guarded to prevent contact with other circuits. When equipment must be moved under powerlines, where clearance is questionable, the power should be removed from these circuits, or other precautions should be taken to prevent contact with energized circuits.

4.02. Transmission lines should be protected against voltage surges, short circuits, and lightning.

4.03. Electric wiring in buildings should be installed so as to minimize fire and contact hazards.

4.04. Transformers less than 8 feet above the ground should be enclosed in a transformer house or surrounded by a suitable fence at least 6 feet high. If the enclosure or fence is of metal, it should be grounded effectively. The gate or door to the enclosure should be kept locked, except during ingress and egress of personnel.

4.05. Transformers containing flammable oil and installed where they may become a fire hazard should be provided with means to drain or confine the oil in event of rupture of the transformer casing.

4.06. Suitable danger signs should be posted conspicuously at all transformer stations less than 8 feet above the ground and at all other high-voltage installations.

4.07. Transformer stations, powerplants, substations, pump stations, and compressor stations should be kept free of nonessential combustible material and refuse and should be ventilated.

4.08. Housings enclosing oil switchgear should be ventilated.

4.09. Power wires, including cables encased in armor, should have adequate current-carrying capacity and should be guarded from mechanical injury.

4.10. Power wires and cables should be insulated adequately throughout their full length in shafts, where they pass into or out of electrical compartments, and where they cross other power wires and cables.

4.11. Metallic sheaths, armors, and conduits enclosing power conductors should be electrically continuous and should be grounded effectively.

4.12. Metallic frames, casings, and other enclosures of electric equipment that can become "alive" through failure of insulation or by contact with energized parts should be grounded effectively, or equivalent protection should be provided.

4.13. Where telephone or signal wires are installed in the same conduit with power cables or conductors, either the telephone and signal wires or the power conductors should be encased in a separate metal covering which should be effectively grounded.

4.14. Each wire, power or lighting circuit, and telephone line that leads underground should be equipped with a suitable lightning arrester. (See Section 12 for Lighting.)

4.15. In alternating-current power systems, where the line-to-ground voltage exceeds 150 volts, the system should be grounded through a suitable impedance at the transformer station, and a suitable neutral or ground conductor should be connected between the impedance and the electric equipment. A relay should be provided to trip the circuit when a fault occurs.

4.16. Automatic circuit-breaking devices or fuses of correct type and capacity should be installed to protect all electric equipment and power circuits against excessive overload. Wires or other conducting materials should not be used as a substitute for properly designed fuses. Circuit-breaking devices should be maintained in safe operating condition.

4.17. Electric equipment and circuits should be provided with switches or other controls of safe design, construction, and installation.

4.18. Operating controls, such as switches, starters, and switch buttons, should be so installed that they are readily accessible and can be operated without danger of contact with moving or "live" parts.

4.19. Disconnecting switches should be installed in all branch circuits near the point of takeoff from main circuit.

4.20. Electric motor-driven coal or rock drills or other electrically operated rotating tools intended to be held in the hands should not be operated at a potential higher than 250 volts and should have the electric switch so constructed as to break the circuit when the hand releases the switch or should be equipped with properly adjusted friction or safety clutches.

4.21. Dry wooden platforms, insulating mats, or other electrically nonconductive materials should be kept in place at each switchboard, power-control switch, and stationary machine where shock hazards exist.

4.22. Resistors or rheostats should be installed in such a manner as not to create a fire hazard and should be guarded adequately against personal contact.

4.23. Electric parts, such as switches, circuit breakers, rheostats, relays, and fuses, should be installed on switchboards or mounted on incombustible bases of "slate" or equivalent insulating material.

4.24. Switchboards should be located so that there is ample room between the switchboard and passageways or lanes of travel and should have an entrance at each end to permit authorized persons to inspect, adjust, or repair apparatus back of the board. Switchboards should have the entrance to the rear guarded against entrance of unauthorized persons, unless in a building that is kept locked.

4.25. Rooms housing switchboards should not be used for the storage of combustible materials and should be kept free of debris and refuse.

4.26. Where a shaft is being sunk in connection with a gassy mine, or where it will penetrate gas-bearing strata, equipment used below the collar of such shaft should be permissible, provided a Bureau of Mines schedule therefor has been established.

4.27. Electric equipment should be inspected each shift by the operator of such equipment or other authorized person, and any dangerous conditions found should be reported and corrected.

4.28. Where trailing cables are used, the cables should be provided with suitable short-circuit protection and a means of disconnecting power from the cable. Splices in trailing cables should be made in a workmanlike manner, mechanically strong, and well insulated.

4.29. Where electric cables are used in shafts, the excess cable should be on anchored reels or looped securely on fixed-type hooks and in such position that the cable length can be adjusted safely, and should not endanger persons working below.

4.30. Repairs of equipment and wiring should be made by authorized persons.

4.31. Power circuits and electrical equipment should be deenergized before work is done on them, and provisions should be made to secure switches in the "off" position to prevent accidental application of power, or suitable signs should be posted to indicate that men are working on equipment or circuits.

(5) Explosives Storage and Transportation

5.01. Separate magazines should be provided for the storage of explosives and detonators.

5.02. Magazines for storing explosives in amounts exceeding 125 pounds should be:

a. Reasonably bulletproof and constructed of incombustible material or covered with fire-resistive material.

b. Provided with doors constructed of 3/8-inch steel plate lined with a 2-inch section of wood, or the equivalent.

c. Provided with dry floors made of wood or other nonsparking material and have no metal exposed inside the magazine.

d. Provided with suitable warning signs located so that a bullet passing directly through the face of the sign will not strike the magazine.

e. Provided with properly screened ventilators.

f. Equipped with no openings except for entrance and ventilation.

g. Kept locked securely when unattended.

5.03. Magazines for storing detonators need not be bulletproof, but they should be in accordance with the provisions of Section 5.02 for storing high explosives.

5.04. Surface explosives-storage magazines should be placed in accordance with the American Table of Distances insofar as feasible and be not less than 200 feet from any shaft opening or vital structure, unless barricaded effectively.

5.05. The area surrounding magazines for not less than 25 feet in all directions should be kept free of rubbish, dry grass, or other material of combustible nature.

5.06. If the magazine is illuminated electrically, the lamps should be of the vaporproof type, installed and wired to present minimum fire and contact hazards.

5.07. Only nonmetallic tools should be used for opening wooden containers. Extraneous materials should not be stored in an explosives or detonator magazine.

5.08. Deteriorated or damaged explosives and detonators should be destroyed immediately after detection by a person experienced in this work.

5.09. The practice of smoking and the use of open flame should be prohibited in or near magazines, on vehicles transporting explosives, and while explosives are being handled.

5.10. Vehicles used in transporting explosives or detonators should be constructed substantially and maintained in good working order, and the ends and sides of the vehicle should be high enough to prevent explosives from falling off. Any exposed metal on the inside of the body that might come in contact with any package of explosives or detonators should be covered or protected with wood or other nonmetallic material. Explosives in open vehicles should be covered with tarpaulins.

5.11. State or other regulations as to the marking of vehicles transporting explosives should be followed. If no laws or regulations are in effect, any such vehicles should be placarded on the front, each side, and the rear with the word "EXPLOSIVES" in letters not less than 8 inches high or should display a red flag with the word "DANGER" in white letters not less than 6 inches high.

5.12. Explosives and detonators should not be transported in the same vehicle, unless they are separated by at least a 4-inch substantially fastened hardwood partition or the equivalent. Other materials should not be hauled with detonators or explosives.

5.13. Explosives should not be transported in any form of pole-type trailer.

5.14. Persons other than those necessary to transport and handle explosives should not ride on vehicles transporting explosives.

5.15. Packages or containers of explosives should not be dropped or otherwise roughly handled. Explosives and detonators should be transported in the original shipping containers or in some other approved container.

5.16. A vehicle containing explosives should never be left standing or unloaded without first stopping the motor and setting the brakes securely and should never be taken into a garage or repair shop. Explosives cases should never be left immediately back of the exhaust.

(6) Timbering; Safeguarding Personnel and Equipment

6.01. The sides of a shaft should be secured for safety. Where it is necessary to line a shaft, the lining should be installed as the excavation progresses. The distance between the end of the lining and the bottom of the shaft should be governed by the condition of the excavation. Where practical, this distance should not exceed 50 feet.

6.02. Telephone service should be provided. This service should include communication with outside sources for emergencies and with the men working in the shaft when ordinary oral communication becomes difficult or when the shaft reaches a depth of 250 feet. A list of numbers to call in an emergency should be posted near the telephones. Telephone wires should be installed so they will not come in contact with power wires.

6.03. When oxygen breathing apparatus or other such protective equipment is not provided, arrangements for obtaining the service of such emergency equipment should be made in advance with the nearest source. Only trained persons should be permitted to use such equipment.

6.04. First-aid supplies, such as blankets, stretchers, splints, and sterile bandages, should be immediately available. Medical, ambulance, and hospital services should be arranged to avoid undue delay in emergency. If possible all shaft men should learn first aid, but in any case there should be enough men trained in first aid to render assistance.

6.05. Protective hats and protective footwear should be worn by employees, officials, and others on the surface and underground where falling objects may cause injury.

6.06. All employees, officials, and others on the surface and underground should wear approved-type goggles or shields where there is a hazard from flying particles. Persons who normally wear eyeglasses should be encouraged to wear optically fitted safety glasses.

6.07. Welders and helpers should use proper shields or goggles to protect their eyes.

6.08. Persons working around moving equipment should wear snug-fitting clothing.

6.09. Protective gloves should be worn when material which may injure the hands is handled, but gloves with gauntlet cuffs should not be worn around moving equipment.

6.10. Men exposed for short periods to gas- , dust- , and fume-inhalation hazards should wear permissible respiratory equipment. When the exposure is for prolonged periods, other measures should be taken to protect workmen or to reduce hazards.

6.11. Stairways, elevated platforms, floor openings, and elevated runways should be equipped with suitable handrails or guardrails and toeboards. Permanent ladders more than 10 feet in height should be provided with back guards, and landings at intervals of not more than 30 feet should be installed. Shaft ladders should project 3 feet above the collar of the shaft, be placed at least 3 inches from the side of the shaft (lined or unlined), and have uniformly placed rungs not to exceed 12 inches apart. All the aforementioned should be securely constructed and properly maintained.

6.12. The collar of a shaft should be extended above the immediate surrounding terrain to prevent material from rolling or sliding into it. Provisions should also be made to divert water from such openings in case of severe rains and flash floods.

6.13. Where men load on or unload from a bucket or cage suspended over or within a shaft, a platform should be provided to secure safe footing for these men.

6.14. A railing should be provided around the shaft collar to guard against unauthorized entrance to the shaft area.

6.15. Material hoppers should be so located, guarded, covered, or otherwise protected as to prevent persons from falling into the hoppers or material from falling upon persons or down shaft openings.

6.16. Safety belts of an approved design and construction and in a safe condition should be worn, properly attached, by all persons working in or over any shaft where there is a drop of 10 or more feet, unless other acceptable means are provided to prevent such persons from falling into the shaft.

6.17. Compressors and compressed-air receivers should be inspected weekly and maintained to insure safe operation. Compressed-air receivers should be provided with pressure gages, pressure-relief valves, and fusible plugs. Sediment in receivers should be blown out at least each working shift. If an air compressor is driven by a diesel or gasoline engine, care should be taken to prevent exhaust gases from entering the air intake.

6.18. Machinery, equipment, appliances, structures, and material-storage areas should be maintained in safe condition and be periodically inspected for defects. Every person observing defects should immediately inform his supervisor.

6.19. Hand tools should be maintained in good condition.

6.20. During the operation of sinking a shaft, an emergency ladderway or an auxiliary hoist, independently powered, should be provided.

6.21. The working area should be kept free of excessive accumulations of water.

6.22. Gears, belts, chains, and other moving parts of machinery and equipment should be provided with proper guards so designed as to prevent injury to employees.

6.23. Machinery should not be repaired or oiled while it is in motion; this does not apply where safe, remote oiling devices are used.

6.24. A guard or safety device removed from any machine should be replaced before the machine is put in operation.

6.25. Mechanically operated grinding wheels should be equipped with:

a. Safety washers and tool rests.

b. Substantial retaining hoods, the hood opening of which should not expose more than a 90° sector of the wheel.

c. Eyeshields, unless goggles are worn by the operators.

6.26. A system that will provide positive identification upon the person of every individual underground should be maintained.

(7) Hoisting, Hauling, and Handling Excavated Material

7.01. a. Hoists used to transport persons should be equipped with brakes capable of stopping the cage, bucket, platform, or other device when fully loaded. The hoisting rope should be adequate to sustain the fully loaded transporting device. Defective ropes should be replaced promptly.

b. When persons are transported by hoist, a second engineer should be in attendance, unless the hoist is fully equipped with overspeed, overwind, and automatic stop devices.

7.02. Hoisting equipment used to transport persons should be inspected daily. The inspection should include the headgear (headframe, sheave wheels, etc.), ropes, connections, links and chains, and other facilities; a record of the inspections should be kept.

7.03. Provisions should be made to swing the hoisting buckets or other such equipment clear enough of the shaft to prevent mucked or other material, including the bucket, from falling back into the shaft while unloading.

7.04. When men are in the shaft, hoisting engines should be in the charge of and operated by a competent hoisting engineer who is familiar with the details of the hoisting engine.

7.05. When the shaft depth exceeds 50 feet, a substantial headframe should be utilized when men are hoisted or lowered. The headframe should be high enough to provide ample clearance between the bottom of the sheave and the top of the cage or bucket. When the shaft depth exceeds 100 feet, substantial shaft guides and guide attachments should be used to prevent the bucket from swinging. Where a crosshead is used, the bucket should not be hung more than 10 feet below the crosshead. The guides and guide attachments should be maintained not more than 75 feet from the shaft bottom.

7.06. Head or angle sheaves should have a diameter of at least 40 times the diameter of the rope. Defective sheaves should be replaced or relined.

7.07. When men are being raised or lowered on a cage the hoisting speed should not exceed 600 feet a minute. The speed of a bucket transporting persons should not exceed 500 feet per minute and should not exceed 200 feet per minute when within 100 feet of any stop. Within these limits the speed should be established by the person in charge, depending on depth of shaft and other conditions. A notice of established speeds should be posted in clear view of the operator.

7.08. After a hoist has been repaired, at the beginning of each shift, and after it has been out of normal service for any reason, it should be operated by the hoisting engineer through one complete cycle of operation before any person is permitted to be transported therewith.

7.09. An accurate and reliable indicator showing the position of the cage or bucket should be placed so as to be in clear view of the engineer.

7.10. The rope should have at least 3 full turns on the drum when extended to its maximum working length and should make at least 1 full turn on the drum shaft, or around the spoke of the drum in case of a free drum, and be fastened securely by means of clamps.

7.11. The hoisting rope should be fastened to its load by a spelter-filled socket or by a suitable thimble and an adequate number of clamps properly spaced and installed.

7.12. Any rope attached to a cage or bucket used for hoisting or lowering men should be provided with 2 bridle chains or cables connected securely to the rope at least 3 feet above the socket or thimble. Hoisting buckets should be secured by means of self-closing hooks.

7.13. Two independent means of signaling should be provided between the hoisting engineer and points where men are required to work in the shaft. At least one of these means should be audible to the hoisting engineer. The signal code in use should be posted at the shaft.

7.14. Any conveyance being lowered in a shaft in which men are working should be stopped at least 15 feet above such men and should proceed only when signaled that the men who may be endangered are in the clear.

7.15. No skip or bucket should traverse the shaft until it has been trimmed to prevent material from falling back down the shaft.

7.16. Not more than four persons should be permitted to ride in a bucket. Riding the rim of any bucket and on the top of a loaded bucket should be prohibited. The number of persons permitted to ride in cages and skips should be limited so as to permit a reasonable amount of standing room and handholds.

7.17. Persons should not be permitted to ride on a cage, skip, or bucket with tools or materials, except when necessary to handle equipment while in transit. Materials should be secured to prevent shifting while being hoisted or lowered. Small tools and materials carried on the person and in handbags are exempted from this provision.

7.18. Taglines for controlling loads should be used wherever practicable.

7.19. Each operating lever on dump-truck hoists should be equipped with a latch or other device that will prevent accidental starting or tripping of the mechanism.

7.20. No person should be permitted to work on the chassis of a truck with the body in a raised position until after the truck body has been securely blocked in position, preferably between the body and the frame. The mechanical hoist mechanism should not be depended on to hold the truck body in a raised position.

7.21. Trip handles for tailgates on dump trucks should be so arranged that in dumping the load the operator will be in the clear.

7.22. Equipment operators should make certain that the way is clear before backing or maneuvering, except when directed by a qualified signalman.

7.23. Drivers of trucks and similar vehicles should leave the cab while the vehicle is being loaded when exposed to danger from suspended or overhead loading equipment.

(8) Ventilation

8.01. Shaft excavations should be ventilated by a fan or fans installed as follows:

a. In fireproof housings.

b. To permit reversing the air current, offset not less than 15 feet from the shaft, and so located that the air will not recirculate and the air current will not otherwise become contaminated.

c. At least 4,000 cubic feet of air a minute should be delivered to the working area, with reasonable reserve to increase the minimum of air required to dilute and render harmless flammable and harmful gases. At all times while men are working in the shaft, the oxygen content of the air should be at least 19.5 percent and the carbon dioxide content not more than 0.5 percent.

8.02. Only qualified persons duly authorized by the superintendent should have charge of the ventilating system.

8.03. The fan should be operated continuously when men are below the surface. Any accidental stoppage or reduction in air flow should be corrected promptly; otherwise, normal work below the surface should be stopped and all the men not needed to make necessary repairs be removed to the surface. Unless the fan is attended constantly, it should be provided with an automatic device to give alarm when the fan slows down or stops.

8.04. The fan or fans should be inspected daily and a record kept of the inspections.

8.05. Ventilation should be measured daily, and a record of the measurements certified by the person making them should be kept.

8.06. Air ducts should be fire resistant and so maintained as to prevent excessive leakage of air. Flexible ducts should be constructed to permit ventilation by either exhausting or blowing methods. When metal air ducts are used, they should be grounded effectively to remove static and other electrical charges. The duct should extend as close to the bottom as necessary to ventilate properly.

8.07. An examination by a competent person, preferably a certified foreman, should be made within 1 hour before the start of each shift before workmen are permitted to enter, and a record of the examination should be kept. The examination should include tests with a permissible flame safety lamp or other approved device for methane and other combustible gases and other hazards.

8.08. Where methane or other combustible gases have been found, tests should be made immediately before and after blasting, before electrical equipment is operated, and frequently during operation of such equipment. Such tests should be made by a competent person, preferably a certified foreman, with a permissible flame safety lamp or other approved device.

8.09. When the methane content of the air exceeds 1 percent, the ventilation should be improved; if the methane content reaches 1-1/2 percent, blasting and other normal operations should cease, and all the men should be removed from the shaft except those needed to improve the ventilation.

(9) Drilling

9.01. Pneumatic drills, hoses and connections, and electric drills and cables should be maintained in good repair.

9.02. The sides of a shaft in the vicinity of drilling should be examined carefully before such operations are begun. Any loose or doubtful pieces of rock should be removed.

9.03. Drilling should not be done until the previously blasted area, including guns (bootlegs) of old holes, is examined for unexploded charges and proper disposition made thereof.

9.04. Holes should be drilled large enough to allow the charge to be inserted without forcing or ramming.

9.05. Air-hose couplings in the working area that are more than 2 inches in diameter should be secured against whipping in case of a break in the compressed-air line.

9.06. Dry drilling, including collaring, should be done only with drills equipped with permissible dust collectors.

9.07. Drilling in old holes or guns (bootlegs) should be prohibited.

9.08. Men should be warned to stay "out of line" when holes are being cleaned with compressed air.

9.09. Drill steel should not be guided by the hands or feet while collaring or drilling, and persons should be prohibited from sitting on pneumatic-type sinking drills.

9.10. Kinking of the air hose to make or break connections should be prohibited.

9.11. One vertical drill hole and at least two angle holes should be drilled to a depth of at least twice that of the drill round for the purpose of exploring the ground to be penetrated in advance of each drill round where water, gas, or other hazardous condition might be intersected. These holes should be plugged at the collar or marked otherwise to prevent their being charged.

(10) Blasting

10.01. Other operations should not be conducted in a shaft while drill holes are being charged and until all shots have been fired.

10.02. Explosives should not be removed from their original wrappers.

10.03. Explosives used in potentially gassy shafts should be of permissible type; however, when explosives other than permissible are used, they should be in Fume Class 1. No black blasting powder, straight nitroglycerin, or frozen dynamite should be used. All explosives charges should be detonated electrically.

10.04. Operations in connection with blasting should not be carried on during electrical storms.

10.05. Primers should be made up at the time the holes are loaded. When it is impracticable to prepare primers in the blasting area, primers may be made on the surface and taken into the shaft in specially constructed, insulated, covered containers.

10.06. Light and power circuits should be disconnected or removed from the blasting area before charging and blasting.

10.07. The leg wires of detonators should be kept shunted until immediately before they are attached to the blasting circuit, and connections should be carefully made and adequately protected.

10.08. An independent circuit should be provided for electric blasting. The circuit should be well insulated and protected from sources of active or stray electric currents, and the wires in the circuit should be short-circuited and not connected to the source of power until ready for firing.

10.09. Shots should be fired from the surface when all men are out of the shaft; the electrical energy for firing should be strong enough to insure detonation of the entire round. The blasting circuit should be tested with a galvanometer before blasting. The area to be blasted should be covered, using mats or other suitable means, to avoid injury and property damage resulting from flying material when the shaft is not deep enough to retain blasted material. Where methane or other combustible gases have not been found and when a permissible blasting unit is used, shots may be fired from an upper level.

10.10. Enough warning should be given so that all persons in the vicinity may reach safety before the blast.

10.11. Only nonmetallic tamping bars should be used for charging and tamping drill holes.

10.12. Misfires during electric blasting should not be approached for at least 5 minutes. The blasting circuit should be disconnected from the source of power and the circuit shunted during the waiting period and checking.

10.13. When a charge has misfired, the misfire should be handled in accordance with legal requirements, the explosives should be detonated by inserting a new primer, or the misfired charge should be washed from the hole with water.

10.14. Drill holes should be stemmed with at least 24 inches of incombustible material, or from the charge to the collar of the hole, unless an approved tamping plug is used.

10.15. After blasting, all wires in the broken rock should be carefully traced and a search made for unexploded cartridges.

10.16. Smoking should not be permitted during the loading of boreholes and preparations for blasting.

10.17. Loose rock and other material should be removed from timbers and platforms after each blast before men are lowered to the shaft bottom.

(11) Welding and Burning

11.01. Gas cylinders should be handled carefully and stored upright. They should not be dropped or permitted to strike other cylinders violently and should be protected against excessive heat, including the continuous direct rays of the sun, and against accumulations of ice and snow.

11.02. Gas cylinders should not be stored near open flame or flammable material, especially oil, grease, or any other substance likely to be ignited, or where they are likely to contact power wires. The cylinders should be fastened securely to prevent falling.

11.03. Oil or grease in the presence of oxygen under pressure is extremely hazardous; therefore, oily or greasy substances should be kept away from cylinders, cylinder valves, couplings, gages, hose, hose connections, and other oxygen apparatus and should not be handled with greasy gloves or while grease-impregnated clothing is being worn.

11.04. The valve-protection cap should be kept tightly in place on the cylinder when the cylinder is not in use.

11.05. Cylinders should be used only when equipped with a suitable and properly protected reducing valve or regulator.

11.06. Neither oxygen nor compressed flammable gases should be used as a substitute for compressed air.

11.07. After a cylinder-valve protective cap is removed and before a regulator is attached, the valve should be directed away from any person and opened an instant to clear the opening of dust and dirt particles.

11.08. Cylinder valves should be opened slowly and only with hand wheels or tools specifically designed for that purpose and left in place while cylinders are in use. Valves of empty cylinders should be closed.

11.09. Equipment should be inspected and tested before use; any defects should be corrected. Cylinders with leaks that cannot be stopped by closing valves or tightening fittings should be taken into the open, away from any source of ignition, and slowly drained. Repairs of such defects should not be attempted.

11.10. The blowpipe should be open long enough to purge the hoselines of any residual mixture before lighting, whenever a new gas cylinder is connected, or whenever the pressure has been cut off a hoseline. A spark lighter should always be used to light torches.

11.11. Oxygen-cylinder valves should be opened completely to reduce the possibility of leakage around the stem.

11.12. The cylinder valve should be closed before the regulator is removed, even when the cylinder is empty.

11.13. Sparks or flame from cutting or welding should not be allowed to come into contact with the cylinder, regulators, or hose.

11.14. Oxygen regulators, hose, or other appliances should not be interchanged with similar equipment intended for other gases.

11.15. A rope or a chain sling should not be used for moving cylinders. A crane should be used only when a cradle or a safe platform carrier is provided.

11.16. Full and empty cylinders should not be stored together; a separate place should be assigned for each. Empty cylinders should be so marked. Cylinders should be used in the order in which they are received.

11.17. Welding or cutting should not be done where there is a possibility of an explosive atmosphere until such atmosphere has been tested. Ample ventilation should be provided during welding or cutting.

11.18. Electric welding operations should be surrounded by adequate screens to protect those in the vicinity from the injurious effect of the arc, and the inside of the screens should be painted black.

11.19. The operator should be protected from burns by suitable heavy leather or asbestos gloves. Wearing oil- or grease-soaked clothing during welding should be prohibited.

11.20. Where welding or burning is to be done, extraneous combustible material should be removed from the immediate area, and any remaining combustible material should be protected against ignition.

11.21. Welding and burning should be prohibited over or near shaft openings, unless such openings are covered and protective measures taken to insure against fire from hot sparks.

11.22. Immediately after welding or cutting operations, the area should be carefully examined for fire.

(12) Lighting

12.01. Lights should be provided as needed in or on surface structures and around the shaft. Flexible lamp cords should be used only for auxiliary lighting. The cord should have extra-heavy insulation, and the lamp and socket should be protected by a suitable guard. When one side of a circuit supplying power to flexible lamp cords is grounded, the plugs connecting the cords to the power source should be polarized so that the shell of the extension lamp socket will always be connected to the grounded conductor.

12.02. While work is in progress in shafts more than 100 feet deep, the portion of the shaft below that depth should be illuminated.

12.03. Open-flame lights of any type should not be permitted in any potentially gassy atmosphere.

12.04. Stationary, extension, and/or temporary lights used in potentially gassy atmospheres should be of explosion-proof construction with approved entrance for power cables and suitable guards to protect the outer globe.

12.05. Lighting fixtures that are suspended from the top of shafts should be supported in a manner to prevent weight or strain on the power conductors at the fixtures.

12.06. Lighting fixtures suspended in shafts should be of such design that they will be subjected to minimum mechanical shock if struck by falling objects.

12.07. Lighting fixtures should be adequately grounded to prevent external arcs as a result of insulation failure or stray currents.

12.08. Portable lights other than approved flame safety lamps or approved electric lamps should not be used in a potentially gassy atmosphere.

APPENDIX

An adequate amount of suitable fire-fighting equipment, such as fire hydrants, hose and nozzles, chemical trucks, fire extinguishers, barrels of water with pails, sand, and rock dust, should be readily accessible and plainly marked. In selecting equipment care should be taken to provide for all classes of fire.

The following explains the National Fire Protection Association (NFPA) classifications, which have been modified slightly by the Bureau of Mines to permit the use of loaded stream extinguishers on Class C fires except where high voltage is likely to be encountered.

(a) Class A fires. Class A fires are defined as those in ordinary solid, combustible materials, such as coal, wood, rubber, textiles, paper, and rubbish. Fires of these materials can be best controlled through the quenching or cooling action of water or solutions containing large proportions of water. Chemical fire extinguishers, such as soda acid, foam, and loaded stream, also can be used successfully on fires in this class. Other types of chemical fire extinguishers are somewhat limited in their effectiveness when used on Class A fires. Rock dust and fine sand may be used; but in some instances, such as overhead fires, these agents are difficult to apply.

(b) Class B fires. Class B fires are defined as those in flammable liquids, such as fuel or lubricating oils, grease, paint, varnish, and lacquer. Blanketing or smothering is essential for fighting this class of fire successfully. Chemical fire extinguishers, such as foam, dry chemical, liquid carbon dioxide, vaporizing liquid, and loaded stream, are suitable for Class B fires. Rock dust or fine sand may be used also. In no case should water be used, unless a "spray," "mist," or "fog" nozzle is provided. Fire-fighting authorities consider Class B fires the most difficult to control; they are likely to spread rapidly.

(c) Class C fires. Class C fires are defined as those in (live) electrical equipment, such as oil-filled transformers, generators, motors, switch panels, circuit breakers, insulated electrical conductors, and other electrical devices. A nonconducting extinguishing agent is essential for fighting fires of this class. Chemical fire extinguishers, such as liquid carbon dioxide, dry chemical, and vaporizing liquid, are suitable for fires in this class. Rock dust or fine sand may be used also, but either of these - the latter in particular - may damage electrical equipment. Loaded stream extinguishers may be used on Class C fires, except where high voltages are likely to be encountered. When the electric circuit has been deenergized, the nonconducting recommendation previously mentioned may be ignored. However, when fire-fighting facilities for Class C fire hazards are being planned this exception should not be given weight. Where electricity is involved in a fire, it is advisable to deenergize the circuit as soon as possible, because, under certain conditions, a fire cannot be extinguished when a live circuit exists at the seat of the fire.

(d) The comparative efficiency ratings of various hand-type fire-fighting facilities commonly used are provided in the following tabulation and should be used in determining the size extinguisher required. The letters A, B, and C indicate suitability according to fire classification, and the numbers represent the quantity needed to provide a fire-fighting unit. The absence of any letter in a rating indicates that the facility should not be used for that particular class of fire or that its efficiency is too limited to be given a rating.

A 12-quart fire pail has a rating of A-5, and a 2-1/2-gallon pump tank has a rating of A-1, indicating that it will take 5 pails of water to equal a 2-1/2-gallon pump tank on a Class A fire. It will take two 10-pound liquid carbon dioxide extinguishers having a rating of B-2 and C-1 to provide a fire-fighting unit for a Class B fire, but only one is needed for a Class C fire; this extinguisher can be used on an A fire, but its efficiency is too limited to be given a rating for such. For example, in the absence of any other letter, a Class A rated extinguisher should not be used on a Class B or C fire, but an extinguisher rated for Class B and C fires may be used on a Class A fire - the absence of the letter A in this case indicates that the efficiency for fighting a Class A fire is limited.

TABULATION OF EFFICIENCY RATINGS

Fire pail (water)	12-quart	A-5		
Pump tank (water)	2-1/2 gallons	A-1		
Gas pressure (water)	2-1/2 gallons	A-1		
Loaded stream[1/]	1 gallon	A-2	B-4	C-4
Do.	1-3/4 gallons	A-1	B-2	C-2
Do.	2-1/2 gallons	A-1	B-1	C-1
Soda acid	1-1/2 gallons	A-2		
Do.	2-1/2 gallons	A-1		
Foam	1-1/2 gallons	A-2	B-2	
Do.	2-1/2 gallons	A-1	B-1	
Liquid carbon dioxide	5 pounds		B-2	C-2
Do.	10 pounds		B-2	C-1
Do.	15 pounds		B-1	C-1
Dry chemical	4 pounds		B-2	C-2
Do.	10 pounds		B-2	C-1
Do.	15 pounds		B-1	C-1
Carbon tetrachloride[2/]	1 quart		B-2	C-2
Do.	2 quarts		B-2	C-2
Do.	1 gallon		B-2	C-1
Do.	2 gallons		B-2	C-1
Sand pails	12-quart		B-5	
(Use should be supplemented by other equipment.)				
Rock dust	Suitable for A, B, or C Fires (See following note)			

Note: Tests to determine the value of rock dust as a fire-extinguishing agent have not been extensive enough to establish a unit value in comparison with accepted standards of the NFPA. Based on the information available, a reasonable value for mine use is that three 80-pound sacks be accepted as one unit for Class A, B, or C fires. A shovel with a long handle will assist greatly in applying the rock dust and reduce loss through waste.

1/ This extinguisher not recommended for use on Class C fires if high voltage is likely to be encountered.

2/ It has never been the policy of the Bureau of Mines to discourage the use of carbon tetrachloride fire extinguishers under all conditions. The Bureau has, however, consistently advised against their use in confined and unventilated places in mines. This type of extinguisher should not be used where there is likelihood of dangerous concentrations of the fumes and gases evolved passing over workmen. Neither should they be used where there is no ready means of escape for the operator, providing he is not properly equipped with respiratory protection.

A publication of the National Fire Protection Association, "Standard for the Installation, Maintenance and Use of Portable Fire Extinguishers," revised May 1957, has recently been made available. Significant changes have been made in the classification and unit value of portable fire extinguishers.

Excerpts from the above publication concerning Classification of Portable Fire Extinguishers and Classification of Fires are as follows:

> 211. In order to express the relative fire extinguishing potential of portable fire extinguishers, the following classification plan has been established.
>
> Classification of Fires.
>
> 221. For all practical purposes, there are three general classes of fires:
>
> (a). Class "A" Fires, defined as fires in ordinary combustible materials such as wood, cloth and paper where the "quenching-cooling" effect of quantities of water or solutions containing large percentages of water is most effective in reducing the temperature of the burning material below the ignition temperature and is, therefore, of first importance.
>
> (b). Class "B" Fires, defined as fires in flammable petroleum products or other flammable liquids, greases, etc. where the "blanketing-smothering" effect of oxygen-excluding media is most effective.
>
> (c). Class "C" Fires, defined as fires involving electrical equipment where the electrical nonconductivity of the extinguishing media is of first importance.
>
> Classification of Fire Extinguishers.
>
> 231. Based upon the preceding classification of fires and also upon fire extinguishment potentials as determined by physical testing of fire extinguishers by Underwriters' Laboratories, Inc., classifications have been established for portable fire extinguishers.
>
> 232. This classification consists of a NUMERAL and a LETTER. It appears on the label affixed to the extinguishers labeled by Underwriters' Laboratories, Inc., and Underwriters' Laboratories of Canada. This NUMERAL and LETTER connote the following:
>
> (a). In the case of Class "A" extinguishers, the NUMERAL is indicative of the approximate relative fire extinguishing potential of various size Class "A" fire extinguishers, i.e., a 4-A extinguisher can be expected to extinguish approximately twice as much fire as a 2-A extinguisher.
>
> (b). In the case of Class "B" extinguishers, the NUMERAL is also indicative of the approximate relative fire extinguishing potential of various size Class "B" fire extinguishers, and in addition, the NUMERAL is an approximate indication of the square-foot area of deep-layer flammable liquid fire which an average operator can extinguish, i.e., a 10-B unit can be expected to extinguish 10 square feet of deep layer flammable liquid fire when used by an average operator.

(c). In the case of Class "C" extinguishers, no NUMERAL is used since Class "C" fires are essentially either Class "A" or "B" fires involving energized electrical wiring and equipment. The size of the Class "C" extinguishers installed should be commensurate with the size and extent of the area involving the electrical hazard or containing equipment being protected, considering that it must be covered or blanketed by the Class "C" extinguishing media for effective fire extinguishment.

(d). The LETTER refers to the class of fire (see Paragraph 221 preceding) on which the use of the particular extinguisher is approved for most effective fire extinguishment.

Examples.

Foam extinguisher, rated 2-A,4-B. This extinguisher should extinguish approximately twice as much Class "A" fire as a 1-A extinguisher, and four times as much Class "B" fire as a 1-B extinguisher. Also, the extinguisher should extinguish a fire in a deep-layer flammable liquid, such as a dip tank having a surface area of 4 square feet, when used by an average operator.

Dry chemical extinguisher, rated 6-B,C. This extinguisher should extinguish approximately six times as much Class "B" fire as a 1-B unit and should successfully extinguish a deep-layer flammable liquid fire of 6-square-foot area when used by an average operator. It also is safe to use on fires involving electrical equipment.

APPROXIMATE CONVERSION TABLE

		Classification Under Old Method			Approximate Classification Under Present Method		
Water - Fire pail	12 quarts	A-5					
Water							
6 10-quart pails and 25 gallon cask (minimum)					2-A		
Water - 2-1/2 gal. pump tank		A-1			2-A[1]		
Loaded stream	1 gallon	A-2	B-4	C-4	1-A		
Do.	1-3/4 gallons	A-1	B-2	C-2	2-A	1/2-B	
Do.	2-1/2 gallons	A-1	B-1	C-1	2-A	1/2-B	
Soda acid	1-1/2 gallons	A-2			1-A		
Do.	2-1/2 gallons[2]	A-1			2-A		
Foam[3]	1-1/2 gallons	A-2	B-2		1-A	2-B	
Do.	2-1/2 gallons	A-1	B-1		2-A	4-B	
Liquid carbon dioxide[4]	5 pounds		B-2	C-2			
Do.	6 pounds or less					1-B	C
Do.	10 pounds		B-2	C-1		4-B	C
Do.	15 pounds		B-1	C-1		4-B	C
Dry chemical	4 pounds		B-2	C-2			
Do.	6-1/4 pounds or less					4-B	C
Do.	10 pounds		B-2	C-1		8-B	C
Do.	15 pounds		B-1	C-1		8-B	C
Carbon tetrachloride[5]	1 quart (pump)		B-2	C-2		1/2-B	C
Do.	2 quarts (pressure)		B-2	C-2		1-B	C
Do.	1 gallon (do.)		B-2	C-1		1-B	C
Do.	2 gallons (do.)		B-2	C-1			
Do.	3-1/2 gallons (do.)		B-2	C-1		1-B	C
Sand pails (use should be supplemented by other equipment)	12 quarts		B-5				[6]
Rock dust suitable for A, B, and C fires							[6]

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[1] Pump or pressure.

[2] See 221, Section (a) definition Class "A" fires. Also note that A-1 under present Bureau rating is equivalent to 2-A under new N.F.P.A. Standard.

[3] See 221, Section (b) definition Class "B" fires.

[4] See 221, Section (c) definition Class "C" fires, and 232 Section (c). Note that "C" fire extinguishers are designated "C" only. Note carbon dioxide extinguishers with metallic horns will not carry any "C" classification.

[5] Vaporizing liquid (carbon tetrachloride base).

[6] Not rated under present method by N.F.P.A.